

Heavy Lift for Exploration: Options and Utilization

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ABSTRACT

Every study of exploration capabilities since the Apollo Program has recommended the renewal of a heavy lift launch capability for the United States. NASA is aggressively pursuing that capability. This paper will discuss several aspects of that effort and the potential uses for that heavy lift capability.

The need for heavy lift was cited most recent in the findings of the Review of U.S. Human Space Flight Plans Committee.

“Combined with considerations of launch availability and on-orbit operations, the Committee finds that exploration will benefit from the availability of a heavy-lift vehicle,” the report said. “In addition, heavy lift would enable the launching of large scientific observatories and more capable deep-space missions. It may also provide benefit in national security applications.”

The most recent focus of NASA’s heavy lift effort is the Ares V cargo launch vehicle, which is part of the Constellation Program architecture for human exploration beyond low Earth orbit (LEO). The most recent point-of-departure configuration of the Ares V was approved during the Lunar Capabilities concept Review (LCCR) in 2008.

The Ares V first stage propulsion system consists of a core stage powered by six commercial liquid hydrogen/liquid oxygen (LH₂/LOX) RS-68 engines, flanked by two 5.5-segment solid rocket boosters (SRBs) based on the 5-segment Ares I first stage. The boosters use the same Polybutadiene Acrylonitrile (PBAN) propellant as the Space Shuttle. Atop the core stage is the Earth departure stage (EDS), powered by a single J-2X upper stage engine based on the Ares I upper stage engine. The 33-foot-diameter payload shroud can enclose a lunar lander, scientific instruments, or other payloads.

Since LCCR, NASA has continued to refine the design through several successive internal design cycles. In addition, NASA has worked to quantify the broad national consensus for heavy lift in ways that, to the extent possible, meet the needs of the user community.

One of NASA’s most successful efforts to engage potential users in the early concept stage was a pair of weekend workshops at Ames Research Center. Devoted to astronomy and planetary science, these meetings brought together payload and vehicle designers to examine the Ares V design and payloads that might take advantage of its capabilities. The reports from both workshops concluded Ares V would benefit both fields of exploration. It enabled breakthrough astronomy in the case of some payloads, and it made possible other missions that would be extremely difficult otherwise. One of the most obvious examples was planetary sample return missions. Presentations also suggested that such a heavy lift capability might alter the payload design paradigm.

NASA’s heavy lift team most recently began the effort to identify potential payloads. The approach taken has been to determine approximate mass of potential payloads and physical characteristics, payload accommodation requirements, and desired launch date. In parallel, the team has worked to assess the impact to HLLV elements, including a family of shrouds to support study efforts and vehicle configurations and payload capability consistent with payload needs.

Utilization has been grouped by shroud parameters into several mission sets – astronomy, International Space Station (ISS) augmentation, Mars sample return, solar system science, Mars Design Reference Mission 5.0, human near Earth object (NEO), and tanker. In broadest terms, these shrouds vary by shroud diameter and length. Other payload specific changes may include acoustic insulation, payload services and access, and the addition of an upper stage or propellant. The Mars DRA 5.0 mission includes a provision for a “dual-use” shroud that also serves as an entry and landing shell for payloads.